

ENGINEERING DESIGN FILE

Project/Task
Subtask

WAG-7 Data Compilation
Drum Failure Rate Data

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TITLE: SDA Buried Drum Failure Rate Data Compilation

SUMMARY:

The purpose of this EDF is to estimate the failure rate of steel drums containing transuranic (TRU) waste buried in shallow pits and trenches at the Subsurface Disposal Area (SDA). The drum failure rate is based exclusively on data from two previous studies designed to retrieve buried waste and investigate the problems associated with retrieving older buried wastes at the SDA. This report summarizes the drum failure data collected from the drum/waste retrieval programs and consists of a short description of the disposal history of the waste pits and trenches, and information regarding each drum failure data point gathered from the literature. Drum failure data, graphed as a function of burial time was best fit with a power law expression. The data also indicates that the majority of drums buried at the SDA have failed by now.

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SDA Buried Drum Failure Rate Data Compilation

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1. INTRODUCTION

The purpose of this EDF is to estimate the failure rate of steel drums containing transuranic (TRU) waste buried in shallow pits and trenches at the Subsurface Disposal Area (SDA). The drum failure rate is based exclusively on data from two studies developed to retrieve buried waste and investigate the problems associated with retrieving older buried wastes at the SDA. The first study, called the Initial Drum Retrieval (IDR) program (Card and Wang, 1976; McKinley and McKinney, 1978a) was established in 1974 to retrieve the most recently disposed TRU wastes buried in pits 11 and 12 during 1969 and 1970. From July 1974 to June 1978, the IDR program retrieved 20,202 drums from pits 11 and 12 and probed waste in pits 6, 9, and 10. The second study, called the Early Waste Retrieval (EWR) program (Card, 1977; McKinley and McKinney, 1978b; Bishoff and Hudson, 1979) was established in 1976 to retrieve the oldest buried TRU waste. From May 1976 to September 1978, 457 drums and 59 m³ of loose waste and contaminated soil were retrieved from pits 1 and 2 and trenches 1-10.

Analysis of retrieval program documentation provides a means to estimate drum failure rates for different waste burial periods at the SDA. This report summarizes the drum failure data collected from the waste retrieval programs and consists of a short description of the disposal history of the waste pits and trenches, and information regarding each drum failure data point gathered from the literature.

2. DISPOSAL PIT AND TRENCH HISTORY

Drum integrity data points were taken from IDR and EWR reports for pits 1, 2, 9, 10, 11, and 12 and trenches 5, 7, 8, 9 and 10. The locations of these pits and trenches within the SDA are shown in Figure 1. Pit 1 was opened on November 1, 1957 and disposal of TRU waste began at that time. Pit 1 remained open until October 1, 1959 and a total of 7,551 steel drums were placed in the pit. Pit 2 was opened on October 1, 1959 and remained open until July 1, 1963. Pit 2 was temporarily closed from February, 1962 through September, 1962 because of flooding due to heavy rain and melting snow. A total of 22,435 steel drums were placed in Pit 2 during its operation. Pit 9 was open for waste disposal from November 8, 1967 through June 9, 1969. A total of 3921 drums and with 1302 boxes of empty drums were disposed in Pit 9. Pit 10 was opened on August 7, 1968 and closed July 8, 1971. However, drum disposal in Pit 10 was discontinued in January, 1970. A total of 26,645 drums were disposed in Pit 10. Pit 11 was opened April 14, 1970 and closed October 16, 1970 but drum disposal was stopped August, 1970. A total of 13,542 drums were disposed in Pit 11. Pit 12 was opened on July 7, 1970 and closed September 12, 1972. A total of 4,838 drums were disposed in Pit 12.

Trenches 5 through 10 were filled with intermixed waste during the period between 1956 and 1958. The number of steel drums disposed in the trenches was not available in the literature searched. A summary of the opening and closing dates for the trenches and pits is presented in Table 1. Initially, the steel drums were orderly stacked in the disposal pits. However, the procedure of stacking waste was abandoned soon after disposal began in order to decrease exposure to workers. The new procedure was to randomly dump drums into the pits and trenches. In 1969 and 1970 drums containing TRU wastes were again orderly stacked in Pits 11 and 12.

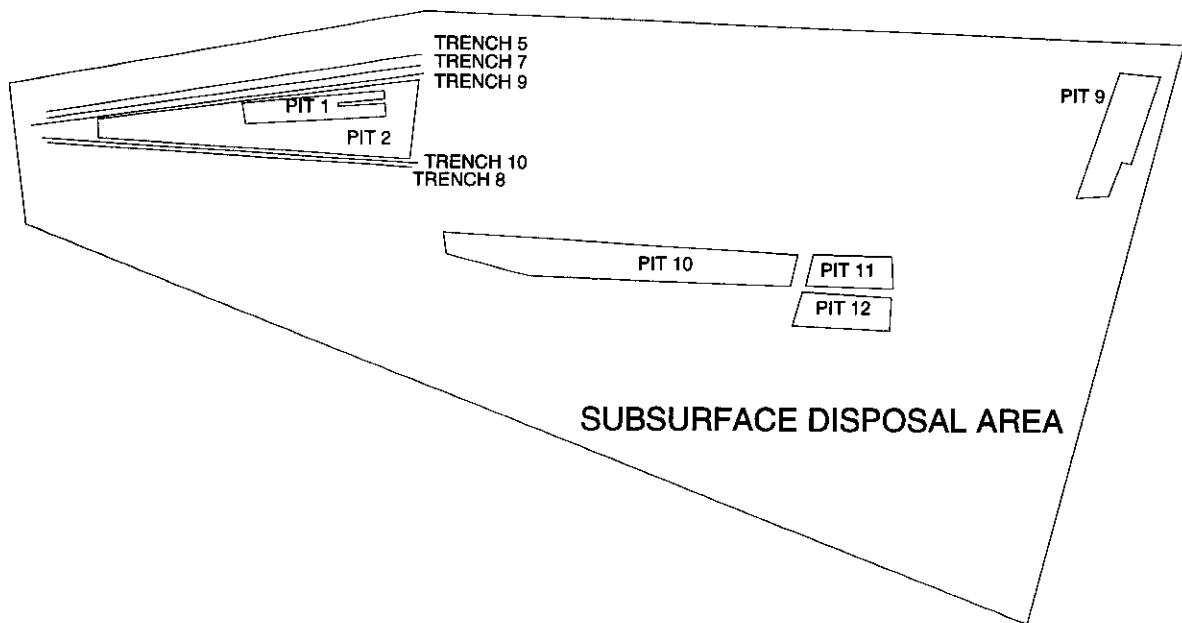


Figure 1. SDA Drum Retrieval and Inspection Locations.

Table 1. Pit and Trench Disposal Periods.

Location	Opening Date	Closing Date
Pit 1	11-01-57	10-01-59
Pit 2	10-01-59	07-01-63
Pit 9	11-08-67	06-09-69
Pit 10	08-07-68	07-08-71
Pit 11	04-14-70	10-16-70
Pit 12	07-02-70	9-12-72
Trench 5	11-04-55	03-29-56
Trench 7	08-14-56	12-20-56
Trench 8	12-13-56	05-07-57
Trench 9	01-07-57	09-06-57
Trench 10	07-19-57	02-07-58

3. DRUM FAILURE DATA POINTS

Estimating the number of failed drums from the IDR and EWR reports was somewhat qualitative. Often, only a description of the retrieved drums was provided. When the number of failed drums was not explicitly stated, the description of the retrieved drums was used to estimate the number of failed drums. The following descriptions were assumed to indicate drum failure:

“breached”,
“obvious corrosion holes”,
“damaged or missing the cover”,
“deteriorated and leaked liquids”,
“completely deteriorated and heavily rusted”,
“damaged severely”, and
“severely deteriorated”.

This section describes each drum failure data point found in the literature. The description consists of the burial location, an estimate of the total burial time, the percentage of drums which had failed, the reference for the data point, and a discussion. A range is listed for the total burial time because of the uncertainty associated with the actual burial and retrieval dates.

1. Pit 11, 58-72 Months, 2 Percent Failure, TREE-1079. This value appears extremely low, but may be correct because the drums emplaced in Pits 11 and 12 were orderly stacked instead of randomly dumped. This is because stacked drums were generally in better condition than dumped drums.
2. Pits 11 and 12, 21-98 months, 8.5 Percent Failure, TREE-1286. This data point is the average for the entire IDR program.
3. Pit 9, 88-118 months, 50 Percent Failure, TREE-1286. All drums uncovered had external alpha contamination, indicating that the failure rate could be higher.
4. Pit 2, 154-204 months, 19 Percent Failure, TREE-1047. This data point is for the first fiscal year of the EWR program and the percentage of breached drums may be higher. Eighty drums were retrieved at the close of the 1976 fiscal year and all were “severely rusted”.
5. Trench 10, 219-227 months, 100 Percent Failure, TREE-1047. A total of forty drums were retrieved from Trench 10. Of the forty, one was completely deteriorated and all the others were “heavily rusted”.
6. Pit 2, 168-202 months, 25 Percent Failure, TREE-1047. Ten of the forty drums extracted from Pit 2 during the transition quarter were breached and leaking. The number of breached drums may have been higher because all the drums were “very rusted”.
7. Pit 2, Trench 8, and Trench 10, 159-249 months, 70 Percent Failure, TREE-1265. This data point is for the total number of drums retrieved for the second fiscal year of the EWR program. The number of breached drums may have been higher because the seventy percent were “severely breached”.
8. Trench 8, 242-247 months, 100 Percent Failure, TREE-1265. All drums retrieved from Trench 8 were “severely deteriorated”.
9. Trench 7, 254-258 months, 100 Percent Failure, TREE-1321. All the twenty-two drums retrieved during February, 1978 were breached.
10. Trench 7, 255-259 months, 50 Percent Failure, TREE-1321. Eight of the sixteen drums

retrieved during March, 1978 were breached.

11. Trench 7, 267-271 months, 83 Percent Failure, TREE-1321. Twenty of twenty-two drums were "badly deteriorated". This data point should be combined with the two previous data points which predicts a 80 percent failure rate for a 254-271 months burial period.
12. Trench 5, 258-262 months, 100 Percent Failure, TREE-1321. All of the twenty-nine drums extracted from Trench 5 were "badly deteriorated".
13. Pit 1, Trench 5, Trench 7, and Trench 9, 239-289 months, 65 Percent Failure, TREE-1321. This data point is for the 1978 fiscal year during which 137 drums were retrieved from the RWMC.
14. Pit 1, Pit 2, Trench 5, Trench 7, Trench 8, Trench 9, Trench 10, 93-255 months, 67 Percent Failure TREE-1321. This data point is for all drums retrieved during the entire EWR program.

The 14 data points listed above are shown in the graph in Figure 2. The error bars indicate the possible range of the drum burial period. In general, the data points taken from locations where the waste drums were orderly stacked, indicated a much lower drum failure rate. This is evident from the relatively low drum failure rates for the drums retrieved from Pits 1, 2, 11, and 12. Although the drums in pits 1 and 2 and the trenches were buried at approximately the same time, the drum failure rates were much lower for the pits than the disposal trenches where drums were randomly dumped. This agrees with observations of drums in pits 9 and 10 where drums were randomly dumped and later compacted by heavy equipment. During the IDR program, drums in pits 6, 9, and 10 were probed to see if they could be retrieved. Because of the poor condition of the drums and boxes, it was recommended the waste not be retrieved as part of the IDR program. The data also suggests the initial failure rate for the randomly dumped drums may have been as high as 40 percent.

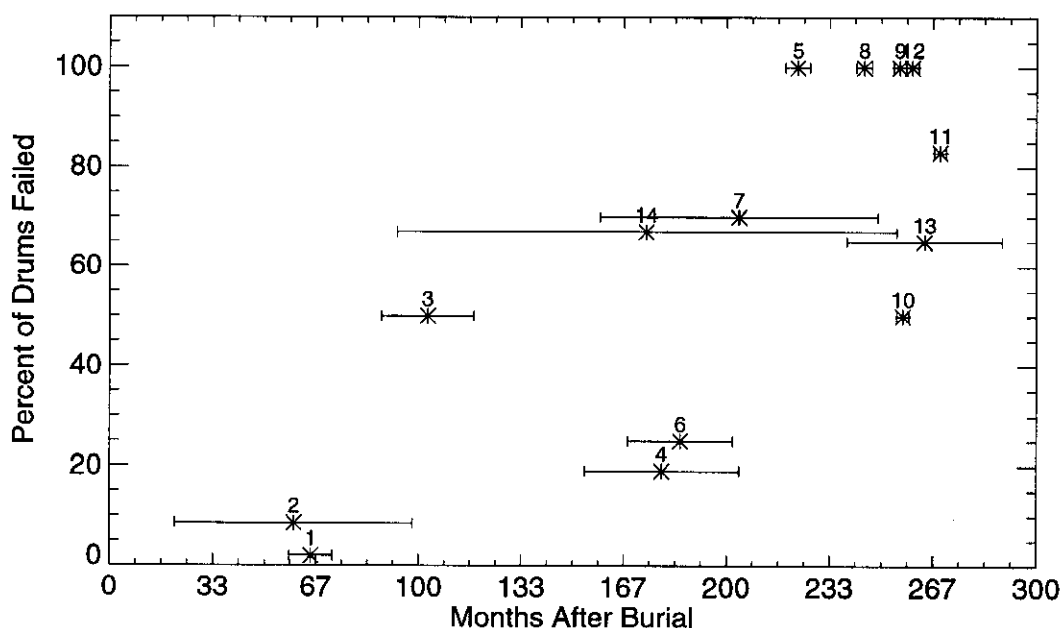


Figure 2. Drum Failure vs. Burial Time.

Several types of regression analysis were applied to the drum failure data to see if one fit was better than another. The curve-fits and regression data are shown in Figure 3 for linear, exponential, logarithmic, and power law expressions. The regression analysis did not distinguish between stacked and dumped drums nor did it account for the uncertainty in burial times. Of the four expressions, the power law expression with an R^2 value of 0.7 provided the best fit. Although this is not a particularly good fit statistically, it is proper given the scatter in the data. Regardless of the regression type, it appears that 85% to 100% of the drums would have failed by now considering the last drums were buried in the SDA approximately 25 years (300 months) ago. For example, the linear regression indicates a drum failure rate of 0.35% per month or 4.2% per year. At this constant rate it would take approximately 24 years for all of the drums to fail.

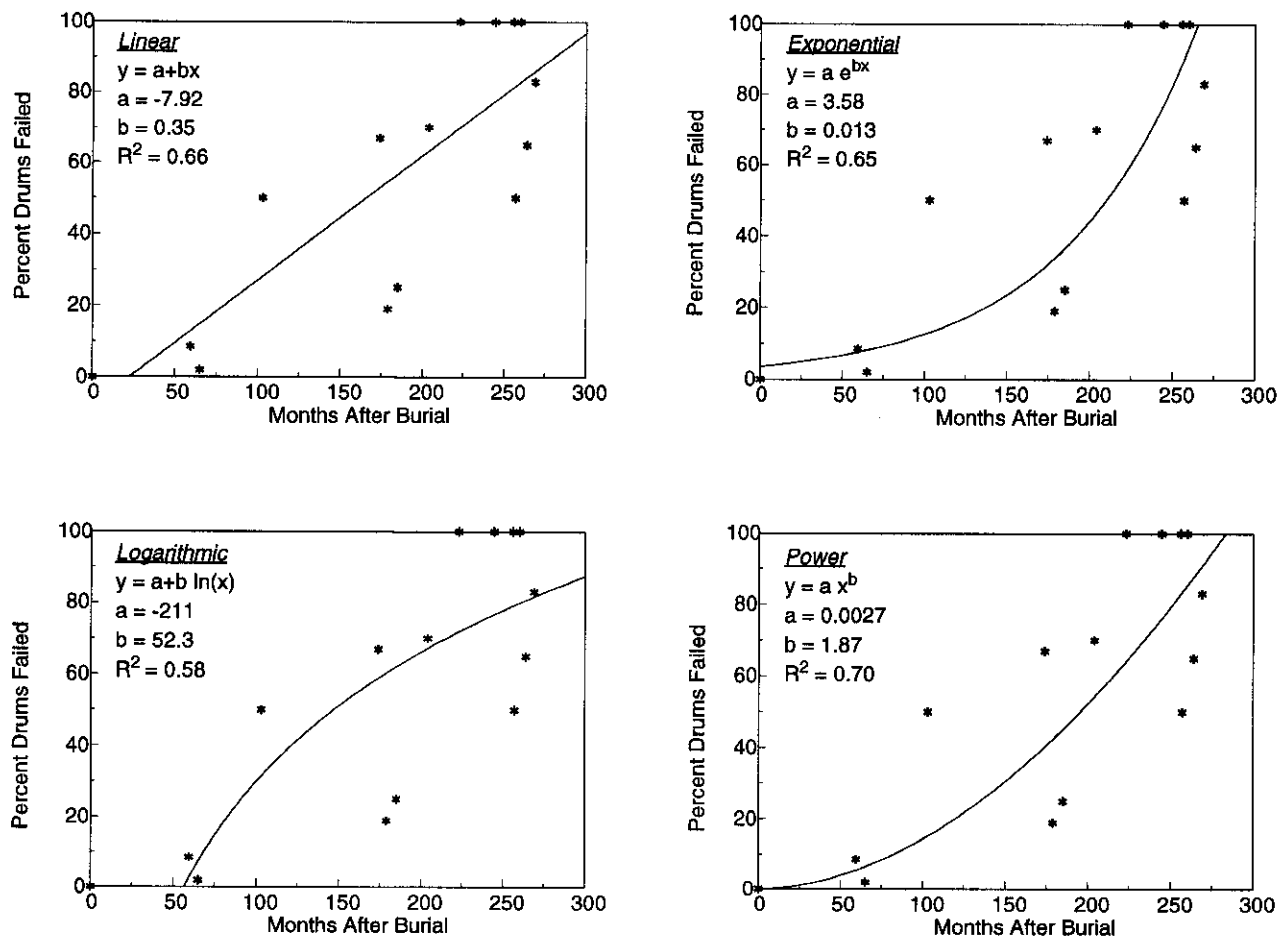


Figure 3. Curve-Fits for Drum Failure Data.

4. REFERENCES

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